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台灣產檬果害蟲 (蟎) 名錄修訂與附記

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摘　　要

根據往昔文獻與過去 4 年野外調查，建立最新的台灣產檬果害蟲 (蟎) 名錄，內容包括 80 種昆蟲與 6 種蟎類的同物異名、生態與經濟重要性之簡要資料，其中二點小綠葉蟬 (*Amrasca biguttula* (Ishida))、內點刺蛾 (*Thosea sinensis* (Walker)) 與小造橋夜蛾 (*Anomis flava* (Fabricius)) 為新興害蟲；檬果壯鋏普癭蚋 (*Procontarinia robusta* Li, Bu & Zhang) 則為台灣首次發生，本文亦將其與檬果癭蚋 (*Procontarinia mangicola* (Shi)) 之形態、生物與生態進行詳細比較。除此，本名錄經過資料考證或試驗，排除 11 種曾被記錄為台灣檬果害蟲的昆蟲，包括窗冠耳葉蟬 (*Ledra auditura* Walker)、褐翅葉蟬 (*Tartessus ferrugineus* Walker)、青翅軍配飛蝨 (*Tambinia debilis* Stål)、穀粒長介殼蟲 (*Duplachionaspis graminis* (Green))、黑長蠣盾介殼蟲 (*Ischnaspis longirostris* (Signoret))、中華褐金龜 (*Adoretus sinicus* Burmeister)、小青銅金龜 (*Anomala albopilosa trachypyga* (Bates))、長金龜 (*Anomala anthusa* Ohaus)、綠豔條金龜 (*Anomala cypriogastra* Ohaus)、櫻花豔條金龜 (*Anomala siniopyga* Ohaus) 與粉吹金龜 (*Dasylepida nana* (Sharp))。

關鍵詞：名錄、昆蟲、蟎類、檬果、台灣。

前　　言

檬果 (*Mangifera indica* L.) 屬於漆樹科 (Anacardiaceae) 植物，原產於印度-緬甸地區 (Indo-Burma region) (Viraktamath, 1989)，為熱帶與亞熱帶國家的重要經濟果樹。根據 FAO 統計資料，2004 年全球已有 92 個國家栽培檬果，栽培面積與產量分別達到 369 萬公

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頃及 2,650 萬公噸，其中印度為栽培面積最大的國家，佔全球 43.36%，印度、中國、泰國、印尼、菲律賓與巴基斯坦等亞洲國家之栽培總面積則達全球 73.79% (Fivaz, 2009)。

台灣栽培檬果最早時間，可追溯自 1562 年荷蘭人將檬果引進台南六甲試植 (Chen, 1991)，至今栽培面積約為 1.68～1.98 萬公頃。以 2010 年為例，臺南市 [往昔之台南縣市] 約有 7,661 公頃、屏東縣約有 6,091 公頃及高雄市 [往昔之高雄縣市] 約有 2,061 公頃，共計達全國總面積的 94.15% (http://www.coa.gov.tw/view.php?catid=23774)；再根據 2004 年我國農業統計年報資料，台灣當年檬果栽培總面積與總產量各為 1.91 萬公頃與 18.22 萬公噸 (http://www.coa.gov.tw/view.php?catid=8908)，雖然只佔當年全世界之 0.52% 及 0.69%，但檬果卻是我國僅次於香蕉的第 2 大外銷鮮食水果 (http://agrapp.coa.gov.tw/TS2/TS2Jsp/TS20104.htm)，同時也是我國內銷市場的重要熱帶果樹，其用途除作為傳統鮮食、果汁、蜜餞與乾果之外，近年更被運用在附加價值較高的冰品與釀酒業等。

檬果害蟲名錄是檬果有害生物整合管理的重要環節之一，由於台灣迄今尚無檬果害蟲名錄的正式調查報告，相關資料僅有 Miwa (1943)、Tsai (1965) 與 Lee (1988) 等 3 篇報告，分別記錄 44、60 與 80 種害蟲，且此三篇資料具有後者援引前者的重要特色，其中 Miwa (1943) 與 Tsai (1965) 因未列出文獻引用來源，致使部份昆蟲是否屬於檬果害蟲，至今仍有存疑。除此，往昔製作農作物害蟲名錄的方式，絕多數僅側重於彙整歷年害蟲學名 (scientific names，包括科名、屬名與種名) 資料，並未考證害蟲分類與生態資訊是否已經改變，致使名錄內容可能出現同物異名 (synonym)、異物同名 (homonym) 與生態資訊誤植等問題，導致後續害蟲防治產生不同程度的困擾，此類問題可參考 Chu and Wu (1989) 的報告。

有鑑於此，本研究針對往昔檬果害蟲文獻資料，提出具有科學根據的資訊考證 (如害蟲種名、寄主植物、生態危害習性與地理分布等資料的確認)，並結合田野調查成果，建立與時俱新的台灣檬果害蟲名錄。在野外調查部分，自 2009 年迄今的野外調查，共計確認二點小綠葉蟬 (*Amrasca biguttula* (Ishida))、內點刺蛾 (*Thosea sinensis* (Walker)) 與小造橋夜蛾 (*Anomis flava* (Fabricius)) 為台灣檬果新興害蟲 (emerging pest)，另於 2011～2012 年在高雄市小港區、林園區與鳳山區以及福建省金門縣所發現的檬果壯鋏普癭蚋 (*Procontarinia robusta* Li, Bu & Zhang)，則為台灣之新紀錄害蟲。本研究最終目標係釐清國內檬果害蟲資訊，期使此官方版研究報告，可成為我國擬定檬果有害生物檢防疫措施的參考依據，並提供貿易進口國公開透明的害蟲資訊，最終更期待本文可成為我國其他農作物害蟲名錄研究的參考模式。

材料與方法

一、台灣產檬果害蟲 (蟎) 名錄修訂

本名錄修訂方法包括 (1) 蒐集日治時期與台灣光復迄今與檬果害蟲調查或名錄有關的研究報告，如 Kato (1928)、Miwa (1943)、Tsai (1965) 與 Lee (1988) (表一)，因此以 1945 年作為考證歷年資料關聯性的時間點，釐清各篇報告所述害蟲之正確性；(2) 自 2009 年 1 月迄今，以黃色黏蟲紙、目視 (檢查檬果組織是否有蟲體或蟲蛻存在)、徒手採集及剪枝等方法，調查檬果產區的害蟲種類，作為增刪名錄的參考依據。其中，黃色黏蟲紙設於台南

市玉井區二處檬果園以及台中市霧峰區農業試驗所，調查頻度每週一次；其餘方法則是在枋山、枋寮、玉井，於檬果開花期至結果期之間，不定期與逢機調查方式予以調查。被採獲的昆蟲，若確定不是往昔文獻所記載的檬果害蟲，經過室內飼育（飼育品種包括愛文與土檨），可存活且具明顯危害者，則列為新興害蟲 (emerging pest)；無法存活者，則依下列的存疑種判定方法，予以進行考證。除此，本研究對半翅目與纓翅目等刺吸式口器昆蟲的寄主判定方式，係根據 Oman (1949) 的定義，即幼期與成蟲期均可在同種植物完成生活史 (life cycle)，則此植物為其寄主植物 (host plants)；反之，某植物僅被幼期或成蟲期取食者，則為食料植物 (food plants)。

本研究之名錄修訂 (revise) 結果詳如表二。表二內容包括每種害蟲所屬之分類階層 (taxonomic category)、學名 (scientific name)、中英文俗名 (common name)、引用文獻 (cited reference)、為害部位與害蟲分級 (category of pest) 等，並以註記 (remarks) 擇要補充某些種類的其他重要資訊；在文字說明部分，害蟲分類階層採用拉丁文與中文並列，方便國內學者或農友查閱該種害蟲的國內防疫資訊；其餘各項資料則以英文描述，使本名錄可成為國際學者與檬果進口國查閱我國官方版檬果害蟲名錄之依據；再者，為縮短學者查閱表二原始引用文獻的時間，特在引用文獻欄位列出每篇文獻的作者、發表年代與資料所屬頁碼；除此，表二之害蟲分級方式，係根據 Pena *et al*. (1997) 的定義，包括 (1) 未採取周年防治策略，即造成重大經濟損失者，以主要害蟲 (major or key pest) 表示，(2) 經濟損害程度不高，一旦栽培管理策略改變、栽培品系改變或用藥不當時，即有可能成為主要害蟲者，則以次要害蟲 (secondary or minor pest) 表示，(3) 在特定時間發生的區域性害蟲，以偶發性害蟲 (occasional pest) 表示，(4) 未被往昔文獻記錄為害蟲，經本研究野外調查與室內飼育，確認可明顯危害檬果組織者，則以新興害蟲 (emerging pest) 表示。

二、台灣產檬果害蟲 (蟎) 之存疑種判定

凡符合下列其中一個要件的物種，則列為台灣檬果害蟲之存疑種 (dubious species)，其結果詳如附錄一，以釐清我國檬果害蟲 (蟎) 資訊，此些要件包括 (1) 首次被記錄為台灣產檬果害蟲，其後未被引用，野外調查亦未曾發現者；(2) 某些屬於多食性昆蟲，在某篇報告被列為檬果害蟲，其後卻無研究報告證明可為害檬果者；(3) 於野外採集以上兩類曾被記錄為檬果害蟲的幼期或成蟲期活體，在農業試驗所進行室內飼育，確認無法取食檬果，而無法存活者；(4) 某種台灣檬果害蟲被文獻記載的年代，有證據顯示台灣當時尚無此種昆蟲存在，其後雖被記錄，但寄主確定不包括檬果者。

三、檬果新興害蟲與新紀錄害蟲

自 2009 年 1 月開始進行野外調查，其後經室內飼育，確認為新興害蟲者，包括二點小綠葉蟬、內點刺蛾與小造橋夜蛾，另確認檬果壯鋏普癭蚋為台灣的新紀錄害蟲，茲將確認方法分述如下。

(一) 二點小綠葉蟬

農業試驗所應用動物組研究人員，於 2009 年以黃色黏蟲紙監測台南市玉井區檬果園的害蟲過程，發現本種葉蟬，其後 Shih *et al*. (2009) 報導二點小綠葉蟬可危害檬果新梢嫩芽、幼葉與花穗，Shih *et al*. (2010a) 與 Shih *et al*. (2010b) 亦證實本種葉蟬可在檬果完成生活史，確認本種葉蟬為檬果新興害蟲。茲將

此些研究的驗證程序簡述如下：(1) 以 9.6% 益達胺溶液 3,000 倍及 62.25% 鋅錳邁克尼可濕性粉劑 600 倍，分別施用於愛文樣果幼苗 (每株至少有 2 個枝條，每枝條至少含 2 個新梢)，連續施用 2 次，每次間隔 5 日，儘可能移除檬果苗木之刺吸式害蟲及葉部常見病原真菌；(2) 經過 7 日後，將幼苗移入養蟲籠 (47.5 × 47.5 × 135 cm)，每籠 1 株；(3) 每一養蟲籠置入 25 對二點小綠葉蟬成蟲，每日觀察檬果葉片是否出現與野外相同的危害徵狀；(4) 觀察雌蟲產卵位置、幼蟲與成蟲取食行為。本研究根據上述流程，補述本種葉蟬危害檬果葉片與花穗的系列變化，作為田間蟲害診斷的參考。

(二) 檬果壯鋏普癭蚋

行政院農業委員會農業試驗所鳳山熱帶園藝試驗分所研究人員，於 2011 年 11 月上旬至 12 月上旬，陸續接獲高雄市小港區民眾寄送疑受造癭昆蟲危害的檬果葉片樣本，隨後轉送至農業試驗所應用動物組，發現此昆蟲與我國往昔已記載的檬果癭蚋 (*Procontarinia mangicola* (Shi, 1980)) 之危害狀與幼蟲化蛹方式相異，懷疑此種癭蚋可能為新紀錄害蟲，後經中興大學昆蟲系楊曼妙副教授與澳洲學者 Dr. Peter Kolesik 共同確認為雙翅目癭蚋科 (Cecidomyiidae) 的檬果壯鋏普癭蚋 (*Procontarinia robusta* Li, Bu & Zhang, 2003)。有關本種癭蚋危害檬果的試驗流程，與前述二點小綠葉蟬相似，但接種成蟲之前，先在養蟲籠中放置一塊沾濕稀釋蜂蜜溶液中 (水：蜂蜜=3：1) 之黃色海綿 (5 × 5 × 2 cm)，使癭蚋可取食海綿表面的蜂蜜溶液；然後將採自高雄小港區的本種癭蚋成蟲，逢機選擇 30 隻置於養蟲籠中，使之自然交尾與產卵於檬果新梢葉片。本研究將簡述本種癭蚋自雌成蟲產卵於檬果葉片開始，至完成一個世代的發育過程與相對之為害徵狀，使農友可據此正確診斷本種癭蚋的為害徵狀，進而採取適當的防治措施。

(三) 內點刺蛾與小造橋夜蛾

在 2010～2011 年於台中市霧峰區、彰化縣芬園鄉與南投縣草屯鎮，發現兩種可取食檬果葉片的蛾類幼蟲，經攜回農試所飼育至成蟲，確認為內點刺蛾與小造橋夜蛾，且其所產後代，仍可在檬果完成生活史，此為此兩種蛾類幼蟲可取食檬果葉片的首次紀錄，確定為台灣的檬果新興害蟲。目前這兩種的田間發生狀況，仍屬於地區性的偶發害蟲，為此本研究擇要列出其危害資訊，以作為學者從事生物學或防治研究的參考資訊。

結　　果

本研究修訂之「台灣產檬果害蟲與害蟎名錄」，總計包括 6 目 27 科 80 種害蟲與 1 目 2 科 6 種害蟎 (表一、二)，其中二點小綠葉蟬、小造橋夜蛾、內點刺蛾為新興害蟲，檬果壯鋏普癭蚋則為新紀錄害蟲。另經過文獻比對、資料考證、實地調查與室內飼育之後，共有 11 種昆蟲被列為台灣檬果害蟲的存疑種，並將之排除於名錄之外。茲將各項研究結果，詳列如下。

一、台灣產檬果害蟲 (蟎) 名錄修訂及存疑種判定

(一) 日治時期 (1945 年之前) 研究資料之考證

自荷蘭人將檬果引進台灣以來，直至日治時期方有 2 篇與台灣檬果害蟲相關之研究資料，包括 Kato (1928) 發表的「數種加害檬果的同翅目」與 Miwa (1943) 所著之「臺灣害蟲名彙」，前者為台灣首篇記載檬果害蟲的報告，包括 5 種可為害檬果的同翅目害蟲；後者

表一　歷年及本研究之台灣產檬果害蟲與害蟎物種總數

Table 1.　Total number of mango pest species of Taiwan from historical studies and present study

Taxonomic category	Total number of mango pest species				
	Kato (1928)	Miwa (1943)	Tsai (1965)	Lee (1988)	Present study
Orthoptera	-	1	1	1	1
Thysanoptera	-	3	2	3	6
Hemiptera	5	28	37	51	46
Lepidoptera	-	9	13	13	19
Coleoptera	-	2	10	11	5
Diptera	-	1	1	1	3
INSECTA	5	44	64	80	80
ARACHNIDA	-	-	-	2	6

則為首部記載可為害台灣魚類、農林牧業植物及其產品的害蟲專書，也是所有研究台灣農作物害蟲的重要文獻，該書共記錄 1,088 種害蟲，並明載 44 種害蟲可為害檬果 (表一、二)。進一步比對 Miwa (1943) 與其他檬果害蟲研究報告的關聯性，發現 Miwa (1943) 未將 Kato (1928) 所記載之窗冠耳葉蟬 (*Ledra auditura* Walker)、褐翅葉蟬 (*Tartessus ferrugineus* Walker) 與青翅軍配飛蝨 (*Tambinia debilis* Stål) 列為檬果害蟲。為此，本研究自 2009 年開始，將此 3 種昆蟲列為待確認的檬果害蟲，結果僅在 2011 年 11 月 16 日，自台南玉井區一處檬果樣區的黃色黏蟲紙，發現 1 隻褐翅葉蟬之雌性成蟲，另 2 種均未於調查樣區的環境發現。根據往昔文獻所列之褐翅葉蟬寄主植物，包括大戟科 (Euphorbiaceae) 的野桐 (*Macaranga tanarius* (L.) Muell. -Arg.) 與血桐 (*Mallotus japonicus*) (Shih *et al.*, unpliblished data)、桑科 (Moraceae) 的愛玉子 (*Ficus pumila* var. *awkeotsang*) 與芸香科 (Rutaceae) 的柑橘 (*Citrus* sp.) (Schumacher, 1915)。因此，本研究另自台中市霧峰區與雲林縣斗六市的野桐，採集褐翅葉蟬若蟲與成蟲各 10 隻，放置於愛文檬果苗予以飼育，結果顯示存活日數最長者不超過 3 日，根據 Oman (1949) 之葉蟬寄主定義，檬果並非褐翅葉蟬之寄主植物。

總結本項考證結果，顯示 1945 年之前，共有 47 種昆蟲被列為台灣產檬果害蟲。其中，Kato (1928) 所列的窗冠耳葉蟬與青翅軍配飛蝨，符合本研究所列「首次被記錄為台灣產檬果害蟲之後，其後未被引用者，野外調查也未曾發現者」之存疑種判定方式；褐翅葉蟬則符合「於野外非檬果植物上，若採得曾被記錄為檬果害蟲活體，經室內飼育確認無法在檬果植株存活者」之存疑種判定方式。據此，將上述 3 種昆蟲列為台灣產檬果害蟲之存疑種 (附錄一)。

(二) 光復迄今 (1945 年之後) 研究資料之考證

1945 年之後與台灣檬果害蟲名錄有關之研究報告，僅有 Tsai (1965) 與 Lee (1988)。Tsai (1965) 所著「臺灣植物害蟲名彙」專書，可危害檬果的害蟲共有 64 種 (表一)，雖然此書之序文明載其資料引用來源，包括 Miwa (1943) 與1945年之後學者所發表的新紀錄害蟲，但該書卻無列出任何引用文獻，亦未指出那些害蟲屬於 1945～1965 年期間的新紀錄害蟲。其後，Lee (1988) 發表「檬果主要害蟲之

生態與防治」，共計列出 80 種檬果害蟲與 2 種檬果害蟎，其資料引用來源以 Tsai (1965) 為基礎，並加入當時之田野調查資料。

為釐清 1945 年之後，台灣產檬果害蟲物種資料的正確性，本研究考證 Miwa (1943)、Tsai (1965) 及 Lee (1988) 彼此間之資料關聯性，結果顯示 Miwa (1943) 共計列出 37 種金龜子可為害農作物，其中長金龜 (*Anomala anthusa* Ohaus)、赤腳青銅金龜 (*A. cupripes* (Hope))、綠豔條金龜 (*A. cypriogastra* Ohaus)、台灣青銅金龜 (*A. expansa* (Bates)), *A. sauteri* Ohaus、櫻花豔條金龜 (*A. siniopyga* Ohaus)、粉吹金龜 (*Dasylepida nana* (Sharp)) [= *Lepidiota nana* Sharp], *Microtrichia formosana* Mooser 與 *Mimera testaceoviridis* Blanchard 被記錄可為害果樹葉部；*Popillia histeroides* Gyllenhal, *Popillia mutans* Newman, 東方白點花金龜 (*Protaetia orientalis sakaii* Kobayashi) [= *Potosia* (*Calopotosia*) *aerata* Niijima et Kinoshita] 與 *Potosia* (*Calopotosia*) *formosana* Moser 則被記錄可為害果樹花序與葉部。由於 Miwa (1943) 並未指出上述 13 種金龜子是否可為害檬果葉部或花序，但 Tsai (1965) 卻將其中之長金龜、赤腳青銅金龜、綠豔條金龜、台灣青銅金龜、櫻花豔條金龜、粉吹金龜與東方白點花金龜列為台灣檬果害蟲，另新增小青銅金龜 (*Anomala albopilosa trachypyga* (Bates)) 與中華褐金龜 (*Adoretus sinicus* Burmeister) 為檬果害蟲。為釐清 Tsai (1965) 所列 9 種金龜子之引用資料來源，遂查閱 1943～1965 年間的 Zoological Records 及 Chiu (1958, 1966) 所著「臺灣昆蟲學文獻索引 (1684～1957)」與「臺灣昆蟲學文獻索引續編 (1957～1966)」兩本專書，結果顯示在此段期間並無研究報告指出此 9 種金龜子可危害台灣的檬果。此後，Anonymous (2003) 指出赤腳青銅金龜、台灣青銅金龜與東方白點花金龜的成蟲可取食檬果葉片。由上可知，Tsai (1965) 所列之中華褐金龜、小青銅金龜、長金龜、綠豔條金龜、櫻花豔條金龜與粉吹金龜等 6 種金龜子，符合本研究所列「某些屬於多食性昆蟲，於台灣從無研究報告證明可為害檬果，但在某篇名錄卻被列為檬果害蟲者」之存疑種判定方式，據此將之列為台灣產檬果害蟲之存疑種 (附錄一)。

除此，考證往昔為害台灣檬果之介殼蟲種類的過程，發現 Tsai (1965) 與 Lee (1988) 將盾介殼蟲科 (Diaspididae) 的穀粒長介殼蟲 (*Duplachionaspis graminis* (Green)) 與黑長蠣盾介殼蟲 (*Ischnaspis longirostris* (Signoret)) 列為台灣檬果害蟲。由於 1965 年之前，Miwa (1943) 並未記載上述 2 種介殼蟲，另 Tao (1978) 指出穀粒長介殼蟲在台灣的寄主植物為台灣蘆竹 (*Arundo formosana* Hack.) 與濱刺麥 (*Spinifex littoreus* (Burm. f.) Merr.)，同時國外亦無研究報告指出檬果為其寄主植物，由此可知穀粒長介殼蟲符合「首次被記錄為台灣產檬果害蟲之後，其後未被引用者，野外調查也未曾發現者」之存疑種判定方式。再者，Wong *et al*. (1999) 首次記載黑長蠣盾介殼蟲分布於台灣，其寄主植物則為桂花 (*Osmanthus fragrans* Lour.)、仙丹花 (*Ixoro chinensis* Lam.) 與桃花心木 (*Swietenia macropnylla* King)，由此可知黑長蠣盾介殼蟲符合「某種台灣檬果害蟲被文獻記載的年代，有證據顯示台灣當時尚無此種昆蟲存在，其後雖被記錄，但寄主確定不包括檬果者」之存疑種判定方式 (附錄一)。

總結本項考證結果，顯示 1945～1988 年共有 8 種昆蟲應排除在台灣產檬果害蟲名錄之外 (附錄一)。

表二　台灣檬果害蟲與害蟎名錄

Table 2. An annotated checklist of mango pest insects and mites from Taiwan

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
ARACHNIDA	蛛形綱			
ACARINA	蟎蜱目			
1. Tetranychidae	葉蟎科			
(1) *Oligonychus mangiferus* (Rahman & Sapra, 1940)	Mango red spider mite/ 檬果葉蟎；檬果小爪蟎	Ho (1988); Lee (1988: 74); Lin and Chen (2008)	L.	**Major**
2. Eriophyidae	銹蟎科			
(2) *Aceria kenyae* (Keifer, 1966) Syn.: *Cisaberoptus kenya* Keifer, 1966	Eriophyid mite/ 檬果節蜱	Lee (1988: 74); Huang *et al.* (1989); Huang *et al.* (1996)	L.	Minor
Remarks: The first record of deuterogyny in a tropical species was *Aceria kenyae* Keifer, 1966 (deutogyne described as *Cisaberoptus*) on mangos throughout the tropics (Flechtmann and Santana, 2007).				
(3) *Spinacus longinquus* Huang *et al.*, 1996	Eriophyid mite/ 檬果節蜱	Huang *et al.* (1996)	L.	Minor
(4) *Spinacus pagonis* Keifer, 1979	Eriophyid mite/ 檬果節蜱	Huang *et al.* (1996)	L.	Minor
Remarks: Huang *et al.* (1996) reported that no apparent damage caused by the two *Spinacus* species on mango trees from Taiwan.				
(5) *Tegonotus mangiferae* (Keifer, 1946)	Eriophyid mite/ 檬果節蜱	Huang *et al.* (1989)	L.	Minor
(6) *Tegonotus paramangiferae* Huang *et al.*, 1989	Eriophyid mite/ 檬果節蜱	Huang *et al.* (1989)	L.	Minor
INSECTA	昆蟲綱			
ORTHOPTERA	直翅目			
1. Tettigoniidae	螽蟖科			
(1) *Phaulula gracilis* (Matsumura and Shiraki, 1908)	Bush cricket, katydid/ 姬擬綠螽	Miwa (1943: 116); Tsai (1965: 14); Lee (1988: 72)	L.	Minor
Remarks: In Taiwan, this species belongs to the polyphagous insects and feeds on many broad-leaved plants. We didn't find it fed on mango leaves during our filed survey in Taiwan between 2009 to 2011.				
THYSANOPTERA	纓翅目			
2. Thripidae	薊馬科			
(2) *Heliothrips haemorrhoidalis* (Bouché, 1833)	Greenhouse thrips/ 變葉木薊馬	Miwa (1943: 107)	L.	Minor
(3) *Megalurothrips typicus* Bagnall, 1915 Synonym: *Taeniothrips varicornis* Moulton, 1928	Thrips/ 檬果花薊馬	Miwa (1943: 108); Tsai (1965: 21); Wang (2002: 218-219)	Fl.	Minor
(4) *Rhipiphorothrips cruentatus* Hood, 1919	Grape vine thrips/ 腹鉤薊馬	Lee (1988: 72); Wang (2002: 134-136)	L.	Minor

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
(5) *Scirtothrips dorsalis* Hood, 1919	Chilli thrips, Yellow tea thrips/ 小黃薊馬	Miwa (1943: 107); Tsai (1965: 20); Lee (1988: 72)	L., Fl., Fr.	**Major**
Remarks: The species *S. dorsalis* is one of the major pests of mango in Taiwan. It occurs on all the above-the-ground young tissues (young leaves, tender shoot, flowers, fruit-stalks and young fruits) of mango, and creates damaging feeding scars on mango tissue. Efficient detection and reliable identification of this species are key prerequisites for developing practices to manage it (Lin *et al*. 2010).				
(6) *Selenothrips rubrocinctus* (Giard, 1901)	Red-banded thrip/ 赤帶薊馬	Wang (2002: 137-139)	L.	Minor
(7) *Thrips hawaiiensis* (Morgan, 1913)	Hawaiien flower thrip/ 花薊馬	Lee (1988: 72)	Fl.	Minor
HEMIPTERA	半翅目			
Remarks: The phloem feeders of hemipteran insects (e.g. phloem-feeding leafhoppers, scale insects, aphids, psyllids, and planthoppers) cause economic damage directly to mango through phloem feeding and indirectly through the promotion of sooty mould growth.				
3. Cicadellidae	葉蟬科			
(8) *Amrasca biguttula* (Ishida, 1913)	Cotton leafhopper, Indian cotton jassid, Okra leafhopper/ 二點小綠葉蟬	Shih *et al*. (2009); Shih *et al*. (2010a, b)	L., Fl.	**Emerging pest; Major**
Remarks: The typhlocybine species *A. biguttula* is an emerging pest of mango in Taiwan (Shih *et al*. 2009; Shih *et al*. 2010a, b). It feeds on young shoots and leaves of mango trees, and produces irregular hopper burn along the lateral margin to apical part on leaves. We also found this leafhopper species caused significant economic losses to mangos with the thrip species *S. dorsalis* Hood in Yuchin and Nanhua areas of Tainan City (southern Taiwan).				
(9) *Idioscopus clypealis* (Lethierry, 1889)	Mango green leafhopper/ 檬果綠葉蟬	Miwa (1943: 75); Tsai (1961: 115); Tsai (1965: 37); Lee (1988: 72)	L., Fl.	**Major**
(10) *Idioscopus nitidulus* (Walker, 1870) Synonym: *Idioscopus niveosparsus* (Lethierry, 1889)	Mango brown leafhopper/ 檬果褐葉蟬	Kato (1928); Miwa (1943: 75); Tsai (1961: 115); Tsai (1965: 37); Lee (1988: 72)	L., Fl.	**Major**
4. Psyllidae	木蝨科			
(11) *Microceropsylla nigra* (Crawford, 1919)	Mango psyllid/ 檬果木蝨	Miwa (1943: 80); Kato (1928); Tsai (1965: 42); Lee (1988: 72)	L.	Minor
5. Aphidae	蚜蟲科			
(12) *Greenidea mangiferae* Takahashi, 1925	Mango aphid/ 檬果毛蚜	Miwa (1943: 89); Tsai (1965: 62); Lee (1988: 72); Anonymous (2003)	T.	Minor
(13) *Toxoptera odinae* (van der Goot, 1917)	Mango aphid/ 烏桕蚜	Miwa (1943: 86); Tsai (1965: 70); Lee (1988: 72); Tao (1999a: 93); Anonymous (2003)	T.	Minor

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
6. Margarodidae	碩介殼蟲科			
(14) *Icerya aegyptiaca* (Douglas, 1890)	Breadfruit mealybug / 埃及吹綿介殼蟲	Lee (1988: 73)	L.	Occasional pest (local region)
Remarks: The species *I. aegyptiaca* lives on a wide variety of hosts (especially woody plants), but it is very rare on mango trees in Taiwan. Lee (1988) reported this species associated with mango from the field survey by Prof. T. H. Su. Afterwards, no information for this species was reported from Mango trees of Taiwan. For example, Tao (1999b: 3) listed nine plant species as host plants for this species, but mango was not one of them.				
(15) *Icerya purchasi* Maskell, 1878	Cottony cushion scale/ 吹綿介殼蟲	Lee (1988: 73)	S., T.	Minor
(16) *Icerya seychellarum* (Westwood, 1855) Syn.: *Icerya okadae* Kuwana, 1907	Okada cottony-cushion scale/ 岡田吹綿介殼蟲	Miwa (1943: 100); Tsai (1965: 72); Lee (1988: 73)	S., T	Minor
7. Kerriidae	膠蟲科			
(17) *Kerria greeni* (Chamberlin, 1923) Syn.: *Laccifer greeni* Chamberlin, 1923	Lac insects/ 黃膠介殼蟲	Takahashi (1928: 261); Miwa (1943: 100); Tsai (1965: 72); Tao (1978: 108); Lee (1988: 73)	S., T.	Minor
(18) *Kerria lacca* (Kerremans, 1782)	The commercial lac scale/ 膠蟲	Tsai (1965: 72); Hwang and Hsieh (1981); Lee (1988: 73)	S., T.	Minor
8. Pseudococcidae	粉介殼蟲科			
(19) *Planococcus citri* (Risso, 1813) Syn.: *Pseudococcus citri* (Risso, 1813)	Citrus mealybug/ 柑桔粉介殼蟲	Miwa (1943: 103); Tsai (1965: 75)；Lee (1988: 73); ANONYMOUS (2003: 22)	Fr., L., T.	Minor
(20) *Pseudococcus longispinus* (Targioni- Tozzetti, 1867)	Long-tailed mealybug/ 長尾粉介殼蟲	Tsai (1965: 76); Lee (1988: 73)	Fr., L., T.	Minor
9. Coccidae	介殼蟲科			
(21) *Ceroplastes ceriferus* (Fabricius, 1798)	Indian wax scale/ 角蠟介殼蟲	Miwa (1943: 96); Tsai (1965: 77); Tao (1978: 79)	L.	Minor
Remarks: Tao (1978) misspelled the species *Ceroplastes ceriferus* as *C. ceriferens*.				
(22) *Ceroplastes floridensis* Comstock, 1881	Soft scale/ 白蠟介殼蟲、柑桔蠟介殼蟲	Miwa (1943: 96); Tsai (1965: 77); Tao (1978: 79); Lee (1988: 72); Tao (1999b: 52)	L.	Minor
(23) *Ceroplastes pseudoceriferus* (Green, 1935)	Indian wax scale/ 角蠟介殼蟲	Wen and Lee (1986); Lee (1988: 72); Anonymous (2003)	L.	Minor
(24) *Ceroplastes rubens* Maskell, 1892	Red wax scale/ 紅蠟介殼蟲	Tsai (1965: 77); Tao (1978: 79); Lee (1988: 72)	L.	Minor

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
(25) *Coccus acutissimus* (Green, 1896) Syn.: *Leacnium acutissimum* Green, 1896; *Coccus acutissimus* (Green, 1896)	Slender soft scale/ 浪板介殼蟲、黑細扁介殼蟲	Takahashi (1928); Miwa (1943: 97); Tsai (1965: 78); Tao (1978: 80); Lee (1988: 72); Tao (1999b: 53)	L.	Minor
Remarks: Takahashi (1928) reported *C. acutissimus* as new recorded species from Taiwan and noted *Artocarpus integrifolia* as its host plant. Afterward, some authors recorded 5 plant species as host plants for this scale species, including mango (Miwa 1943; Lee 1988; Tao 1999b), longan (Miwa 1943; Tao 1978), and *Eugenia jambos*, *Michelia longifolia*, and *Michelia* sp. (Tao 1978).				
(26) *Coccus discrepans* (Green, 1904)	Soft scale/ 柑桔介殼蟲	Miwa (1943: 97); Tsai (1965: 78); Lee (1988: 72); Tao (1999b: 53)	L.	Minor
(27) *Coccus hesperidum* Linnaeus, 1758	Brown soft scale/ 扁介殼蟲	Tao (1978: 80); Lee (1988: 72)	L.	Minor
(28) *Coccus mangiferae* (Green, 1889)	Mango shield scale/ 檬果扁介殼蟲	Miwa (1943: 97); Tsai (1965: 78); Tao (1978: 81); Lee (1988: 72)	L.	Minor
(29) *Coccus pseudohesperidum* (Cockerell, 1895)	Orchid soft scale/ 偽扁介殼蟲	Lee (1988: 72)	L.	Minor
(30) *Eucalymnatus tessellatus* (Signoret, 1873) Syn.: *Lecanium perforatum* Newstead, 1902; *L. subtessellatum* Green, 1904	Palm scale, Tessellated scale/ 紅褐網介殼蟲、龜甲扁介殼蟲	Miwa (1943: 98); Tsai (1965: 79); Tao (1978: 81); Lee (1988: 72)	L.	Minor
(31) *Kilifia acuminate* (Signoret, 1873)	異足凱介殼蟲	Lee (1988:72)	L.	Minor
(32) *Platysaissetia formicarii* (Green, 1896) Syn.: *Saissetia formicarii* (Green, 1896); *Lecanium globulosum* Maskell, 1897	Soft scale/ 蟻台硬介殼蟲	Miwa (1943: 104); Tsai (1965: 82); Tao (1978: 83); Lee (1988: 72); Tao (1999b: 54)	L.	Minor
(33) *Protopulvinaria mangiferae* (Green, 1889)	Soft scale/ 檬果原綿介殼蟲	Lee (1988: 72)	L.	Minor
(34) *Pulvinaria psidii* Maskell, 1892 Syn.: *Chloropulvinaria psidii* (Maskell, 1892)	Green shield scale/ 黃綠綿介殼蟲、楊桐綿介殼蟲	Miwa (1943: 104); Tsai (1965: 81); Tao (1978: 83); Lee (1988: 72)	L.	Minor
(35) *Pulvinaria taiwana* Takahashi, 1929	Soft scale/ 檬果綿介殼蟲	Tsai (1965: 81-82); Tao (1978: 83); Lee (1988: 72)	L.	Minor
(36) *Saissetia coffeae* (Walker, 1852) Syn.: *Lecanium hemisphaerica* Targioni- Tozzetti, 1867	Hemispherical scale/ 柑桔球介殼蟲	Miwa (1943: 105); Tsai (1965: 82-83); Tao (1978: 83-84); Lee (1988: 72)	L.	Minor

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
(37) *Saissetia oleae* (Oliver, 1791)	Black scale/ 工背硬介殼蟲	Miwa (1943: 105); Tsai (1965: 82); Tao (1978: 84); Lee (1988: 72)	L.	Minor
(38) *Vinsonia stellifera* (Westwood, 1871)	Stellate scale/ 海星蠟介殼蟲	Miwa (1943: 106); Tsai (1965: 83); Tao (1978: 84); Lee (1988: 72)	L.	Minor
10. Diaspididae	**盾介殼蟲科**			
(39) *Aonidiella aurantii* (Maskell, 1878)	California red scale/ 橘紅腎圓盾介殼蟲	Miwa (1943: 94); Tsai (1965: 83); Lee (1988: 72)	L.	Minor
(40) *Aspidiotus destructor* Signoret, 1869	Coconut scale, Transparent scale/ 淡薄圓盾介殼蟲	Miwa (1943: 94); Tsai (1965: 84); Tao (1978: 88); Lee (1988: 72)	L.	Minor
(41) *Aulacaspis tubercularis* (Newstead, 1906) Syn.: *A. cinnamomi* Newstead, 1908; *A. mangiferae* Sasscer, 1912	Mango scale; white mango scale/ 檬果輪盾介殼蟲	Miwa (1943: 95); Tsai (1965: 85); Lee (1988: 72)	L., T.	Minor
(42) *Chrysomphalus aonidum* (Linnaeus, 1758) Syn.: *Chrysomphalus ficus* Ashmead, 1880	Florida red scale/ 褐圓介殼蟲	Miwa (1943: 96); Tsai (1965: 87); Tao (1978: 91); Lee (1988: 72)	L.	Minor
(43) *Chrysomphalus dictyospermi* (Morgan, 1889)	Spanish red scale/ 蜜柑灰介殼蟲	Miwa (1943: 96); Tsai (1965: 87); Lee (1988: 72)	L.	Minor
(44) *Duplaspidiotus claviger* (Cockerell, 1901)	Camellia mining scale/ 山茶花盾介殼蟲	Lee (1988:73)	L.	Minor
(45) *Fiorinia fioriniae* (Targionia-Tozzetti, 1867)	Avocado scale/ 木葉介殼蟲	Tsai (1965: 89); Tao (1978: 100); Lee (1988: 73)	L.	Minor
(46) *Hemiberlesia cyanophylli* (Signoret, 1869) Syn.: *Aspidiotus cyanophylli* Signoret, 1869; *Abgrallaspis cyanophylli* (Signoret, 1869)	Cyanophyllum scale/ 擬櫛圓盾介殼蟲	Miwa (1943: 94); Tsai (1965: 84); Lee (1988: 73)	L.	Minor
Remarks: Cyanophyllum scale has not universally been adopted as a *Hemiberlesia* species, and may be reverted to *Abgrallaspis* (Charles & Henderson 2002).				
(47) *Hemiberlesia lataniae* (Signoret, 1869)	Latania scale/ 椰子白圓介殼蟲	Miwa (1943: 94-95); Tsai (1965: 84); Tao (1978: 89-90); Lee (1988: 73)	L.	Minor
(48) *Hemiberlesia rapax* (Comstock, 1881) Syn.: *Aspidiotus camelliae* Signoret, 1869	Greedy scale/ 棕櫛圓盾介殼蟲	Tsai (1965: 84); Lee (1988: 72)	L.	Minor

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
(49) *Lepidosaphes laterochitinosa* Green, 1925 Syn.: *Lepidosaphes bladhiae* Takahashi, 1931; *Lepidosaphes kamakurensis* Luwana, 1925	Diaspidid insect/ 紫金牛牡蠣介殼蟲	Tsai (1965: 90); Lee (1988: 73)	L.	Minor
(50) *Lindingaspis rossi* (Maskell, 1890) Syn.: *Chrysomphalus rossi* (Maskell, 1890)	Circular black scale/ 黑星圓介殼蟲	Miwa (1943: 96); Tsai (1965: 87); Tao (1978: 91-92); Lee (1988: 73)	L.	Minor
(51) *Parlatoria proteus* (Curtis, 1843)	Orchid parlatoria scale/ 黃片盾介殼蟲	Miwa (1943: 102); Tsai (1965: 93); Tao (1978: 86); Tao (1999: 107)	L.	Minor
(52) *Pseudaulacaspis cockerelli* (Cooley, 1897)	Oleander scale, Oyster scale/ 椰子擬輪盾介殼蟲	Lee (1988: 73)	L.	Minor
11. Kermesidae	**絳介殼蟲科**			
(53) *Kermes formosanus* Takahashi, 1929	Kermesid scale/ 臺灣絳介殼蟲	Lee (1988: 73)	L.	Minor
LEPIDOPTERA	**鱗翅目**			
12. Cossidae	**木蠹蛾科**			
(54) *Zeuzera coffeae* Nietner, 1861	Coffee carpenter/ 咖啡木蠹蛾	Tsai (1965: 95); Lee (1988: 73)	S.	Minor
13. Geometridae	**尺蠖蛾科**			
(55) *Pingasa ruginaria* (Guenée, 1857) Syn.: *Hypochroma ruginaria* Guenée, 1857; *Hypochroma perfectaria* Walker, 1860; *Pingasa ruginaria pacifica* Inoue, 1964	Geometrid moth/ 台灣青尺蠖、黃基粉尺蠖	Miwa (1943: 55); Tsai (1965: 121); Lee (1988: 74)	L.	Minor
Remarks: The species name *Pingasa ruginaria* was misspelled as *P. rugnaria* by Miwa (1943), Tsai (1965), and Lee (1988).				
(56) *Thalassodes vararia* Guenée 1971	Geometrid moth/ 檬果青尺蠖	Miwa (1943: 55); Tsai (1965: 121); Lee (1988: 74)	L.	Minor
14. Gracillariidae	**細蛾科**			
(57) *Acrocercops isonoma* Meyrick, 1916	Mango leafminer/ 檬果細蛾	Miwa(1943: 38); Tsai (1965: 96)	S., L.	Minor
Remarks: Miwa (1943) and Tsai (1965) reported *Acrocercops isonoma* Meyrick, 1916 is one of mango insect pests. Afterwards, the species name *Acrocercops astaurota* Meyrick, 1922 was used in Lee (1988: 73) and Anonymous (2003) as the mango leafminer of Taiwan. According to the moth fauna of Taiwan (http://taibnet.sinica.edu.tw/), the genus *Acrocercops* comprises 5 species but not includes the species *A. astaurota*. The larvae of *A. isonoma* attack the leaves and tender twigs of mango based on our field survey, but no apparent damage caused by this moth on mango.				
15. Lasiocampidae	**枯葉蛾科**			
(58) *Trabala vishnou guttata* (Matsumura, 1909)	Lasiocampid moth/ 青枯葉蛾	Tsai (1961: 118)	L., Fl.	Occasional pest (local region)

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
16. Lecithoceridae	折角蛾科			
(59) *Epimactis talantias* Meyrick, 1908	Lecithocerid moth/ 折角蛾	Tsai (1961: 118)	L., Fl.	Occasional pest (local region)
17. Limacodidae	刺蛾科			
(60) *Thosea sinensis* (Walker, 1855)	Nettle grub/ 內點刺蛾	**Present study**	L.	**Emerging pest; Occasional pest (local region)**
18. Lymantriidae	毒蛾科			
(61) *Euproctis taiwana* (Shiraki, 1913) Syn.: *Porthesia taiwana* Shiraki, 1913	Tussock moth/ 台灣黃毒蛾	Tsai (1961: 117); Tsai (1965: 119); Lee (1988: 74)	T., L., Fl.	Minor
(62) *Lymantria xylina* Swinhoe, 1903	Casuarina moth/ 黑角舞蛾、木毒蛾	Chao *et al*. (1996)	L.	Occasional pest (local region)
Remarks: In Taiwan, this species belongs to the polyphagous insects and major pest in forests. Chao *et al*. (1996) firstly recorded the larvae of this species feed on mango leaves from two areas (Changhua County (central Taiwan) and Kuangyinshan (northern Taiwan)). Afterward Anonymous (2003) noted it attacked the mango of Tainan County (southern Taiwan) in April of 2003.				
(63) *Orgyia postica* (Walker, 1855) Syn.: *Notolophorus australis posticus* (Walker, 1885); *Orgyia ceylanica* Niet., 1862; *Orgyia ocularis* Moore, 1879	Cocoa tussock moth, Tussock moth/ 小白紋毒蛾	Miwa (1943: 63); Tsai (1961); Tsai (1965: 118); Lee (1988: 74)	T., L., Fl.	Minor
Remarks: *Orgyia postica* is regarded by some authors to be but a subspecies of *Orgyia australis* (Anonymous, 2012).				
(64) *Olene mendosa* Hubner, 1823 Syn.: *Dasychira divisa* Walker, 1865	Citrus tussock moth/ 柑毒蛾	Anonymous (2003: 50-51)	L., Fl.	Minor
19. Noctuidae	夜蛾科			
(65) *Anomis flava* (Fabricius, 1775) Syn.: *Cosmophila aurantiaca* Prittwitz, 1867	Cotton semi-looper/ 小造橋夜蛾	**Present study**	L.	**Emerging pest; Occasional pest (local region)**
Remarks: It is an emerging pest for young mango trees in central Taiwan (Taichung City, Changhua County, and Nantou County). This species does not cause serious damage to mango trees.				

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
(66) *Chlumetia transversa* (Walker, 1863) Syn.: *Ariola corticea* Snellen, 1880; *Chlumetia guangxiensis* Wu and Zhu, 1981; *Chlumetia guttiventris* Walker, 1866; *Nachaba transversa* Walker, 1863	Mango shoot borer, Mango twig-borer/ 檬果蛀莖夜蛾	Miwa (1943: 58); Tsai (1961: 116-118)；Tsai (1965: 114)；Hung *et al*. (1967); Lee (1988: 74)	T., Fl., Fr.	**Major** (uncontrolled areas)
(67) *Penicillaria jocosatrix* Guenée, 1852 Syn.: *Bombotelia jocosatrix* Guenée, 1852	Mango shoot borer/ 檬果夜盜蛾	Miwa (1943: 58); Tsai (1965: 111); Lee (1988: 73)	L.	Minor
(68) *Spodoptera litura* (Fabricius, 1775)	Taro caterpillar/ 斜紋夜蛾	Tsai (1965: 115); Lee (1988: 74)	L.	Minor
20. Notodontidae	**天社蛾科**			
(69) *Stauropus alternus* Walker, 1855	Lobster caterpillar/ 龍眼天社蛾	Miwa (1943: 54); Tsai (1965: 117); Lee (1988: 74)	L.	Minor
21. Psychidae	**避債蛾科**			
(70) *Eumeta pryeri* (Leech, 1888)	Bagworm moth/ 大避債蛾	Tsai (1965: 109); Lee (1988: 73)	L.	Minor

Remarks: No psychid insect species feeding on mango trees were recorded from Miwa (1943). Tsai (1965) firstly recorded this species that fed on the mango trees in Taiwan. We have observed the larvae of *Eumeta* sp. That fed on the leaves of mongo trees during the filed survey. But, it needs further confirmation by taxonomist in the near future.

22. Tortricidae	**捲葉蛾科**			
(71) *Argyroploce aprobola* (Meyrick, 1911) Syn.: *Temnolopha metallota* Lower, 1901	Leaf roller/ 馬來蒲桃捲葉蛾、灰白捲葉蛾	Miwa (1943: 43); Tsai (1965: 101); Lee (1988: 73)	L.	Minor
(72) *Megaherpystis melanoneura* (Meyrick, 1912) Syn.: *Eucosma melanoneura* Meyrick, 1912	Tortrix moth/ 檬果黑捲葉蛾	Miwa (1943: 42); Tsai (1965: 100); Lee (1988: 73)	L., Fl.	Minor
COLEOPTERA	**鞘翅目**			
23. Bostrichidae	**長蠹蟲科**			
(73) *Sinoxylon mangiferae* Chujo, 1936	Powder-post beetles/ 檬果雙刺長蠹蟲	Chujo (1936); Miwa (1943: 18); Tsai (1965: 135); Lee (1988: 74); Beaver *et al*. (2011)	S.	Minor

Remarks: Beaver *et al*. (2011) reported the distribution of *S. mangiferae* in Thailand and Taiwan, and noted the type series was collected from mango by Chujo (1936), but no report on the biology of the species.

Taxonomic category/ Scientific name	Preferred common name: English/ Chinese	Cited reference with information of mango mite and insect pests from Taiwan	Associated with mango root (R.), stem (S), twig (T), leaf (L.), flower (Fl.), or fruit (Fr.)	Category of pest
24. Curculionidae	象鼻蟲科			
(74) *Xylopsocus capucinus* (Fabricius, 1781)	False powderpost beetle/ 黃腹長小蠹蟲	Miwa (1943: 18); Tsai (1965: 135); Lee (1988: 74)	S.	Minor
25. Scarabaeidae	金龜子科			
(75) *Anomala cupripes* (Hope, 1839)	Green red foot chafer/ 赤腳青銅金龜、大青銅金龜	Tsai (1965: 138); Lee (1988: 74); Anonymous (2003: 57)	Adults: L.	Minor
(76) *Anomala expansa* (Bates, 1866)	Cupreous chafer, Shiny chafer/ 台灣青銅金龜	Tsai (1965: 139); Lee (1988: 74); Anonymous (2003: 57)	Adults: L., Fl., Fr.; Larvae: R.	Minor
(77) *Protaetia orientalis sakaii* Kobayashi, 1994 Syn.: *Protaetia. orientalis* Gony et Percheron, 1833; *Potosia* (*Calopotosia*) *aerata* Niijima et Kinoshita, 1923	Oriental flower beetle/ 東方白點花金龜	Lee (1988: 74); Anonymous (2003: 57)	Adults: L., Fl., Fr.; Larvae: R.	Minor
DIPTERA	雙翅目			
26. Cecidomyiidae	癭蚋科			
(78) *Procontarinia mangicola* (Shi, 1980) Syn.: *Erosomyia mangicola* Shi, 1980	Mango gall midges/ 檬果癭蚋	Anonymous (2003: 62-66)	L.	**Minor**
Remarks: In April 2000, a gall midge species, *P. mangicola*, producing circular blister galls on mango leaves was first found in mango orchards from southern Taiwan (Anonymous 2003). This species belongs to the major pest of mango trees and causes serious economic damage to mango leaves in ill-managed areas, but it will be easily depressed by chemical control. Furthermore, nearly all old galls on damaged leaves provide reservoirs of anthracnose inoculum.				
(79) *Procontarinia robusta* Li, Bu & Zhang, 2003	Mango gall midges/ 檬果壯鋏普癭蚋	**Present study**	L.	**Emerging pest** (limited area)
Remarks: This species that causes bell-shaped galls on mango leaves was found for the first time in 2011 in Kaohsiung city, southern Taiwan and Kimen Islans. The comparisons on biology, gall morphology, and ecology between *Procontarinia mangicola* and *P. robusta* are listed in Table 3.				
27. Tephritidae	果實蠅科			
(80) *Bactrocera dorsalis* (Hendel, 1912) Syn.: *Chaetodacus ferrugineus dorsalis* (Hendle, 1912); *Dacus dorsalis* Hendle, 1912	Oriental fruit fly/ 東方果實蠅	Miwa (1943: 5); Tsai (1961: 116); Tsai (1965: 159); Lee (1988: 74)	Fr.	**Major**

二、檬果新興害蟲與新紀錄害蟲之危害特性

(1) 二點小綠葉蟬對葉片與花穗之危害特性

本研究之野外調查結果，顯示本種葉蟬對不同品系檬果葉部的危害並無差異，並確認可在使君子科 (Combretaceae) 的大葉欖仁 (*Terminalia catappa* L.) 與錦葵科 (Malvaceae) 的洛神花 (*Hibiscus sabdariffa* L.) 完成生活史，並造成葉部不同程度捲曲的危害。

二點小綠葉蟬於檬果之取食及危害特性，與片角葉蟬亞科 (Idiocerinae) 的檬果綠葉蟬 (*Idioscopus clypealis* (Lethierry)) 及檬果褐葉蟬 (*I. nitidulus* (Walker)) 不同。本種葉蟬之若蟲或成蟲口針短，僅能穿刺檬果嫩芽至幼葉期之葉肉細胞或花穗表皮組織，然後吸食其汁液，被刺吸葉片若為紅棕色嫩葉或淺綠色幼葉，其被危害部位初期皆出現暗褐色細點，並隨葉片發育逐漸擴大為不規則水浸狀，發生密度高時，各危害部位水浸狀往近端部葉緣及端部發展，顏色隨後出現褐化與壞疽，使受害葉片焦枯及扭曲變形；另刺吸花穗所造成之傷口，呈褐色細點，易成為白粉病等真菌病原的入侵管道，促使花穗表面皺縮萎凋，使落花或落果比例更高。至於檬果綠葉蟬及檬果褐葉蟬取食部位，包括嫩莖與葉片之韌皮部以及花穗養份，其排出之尿液，因含碳水化合物，故尿液被覆的檬果組織，均成為真菌孢子發芽的處所，形成煤煙病，除影響光合作用，也影響果實發育及外觀品質。

(2) 檬果壯鋏普癭蚋之危害特性

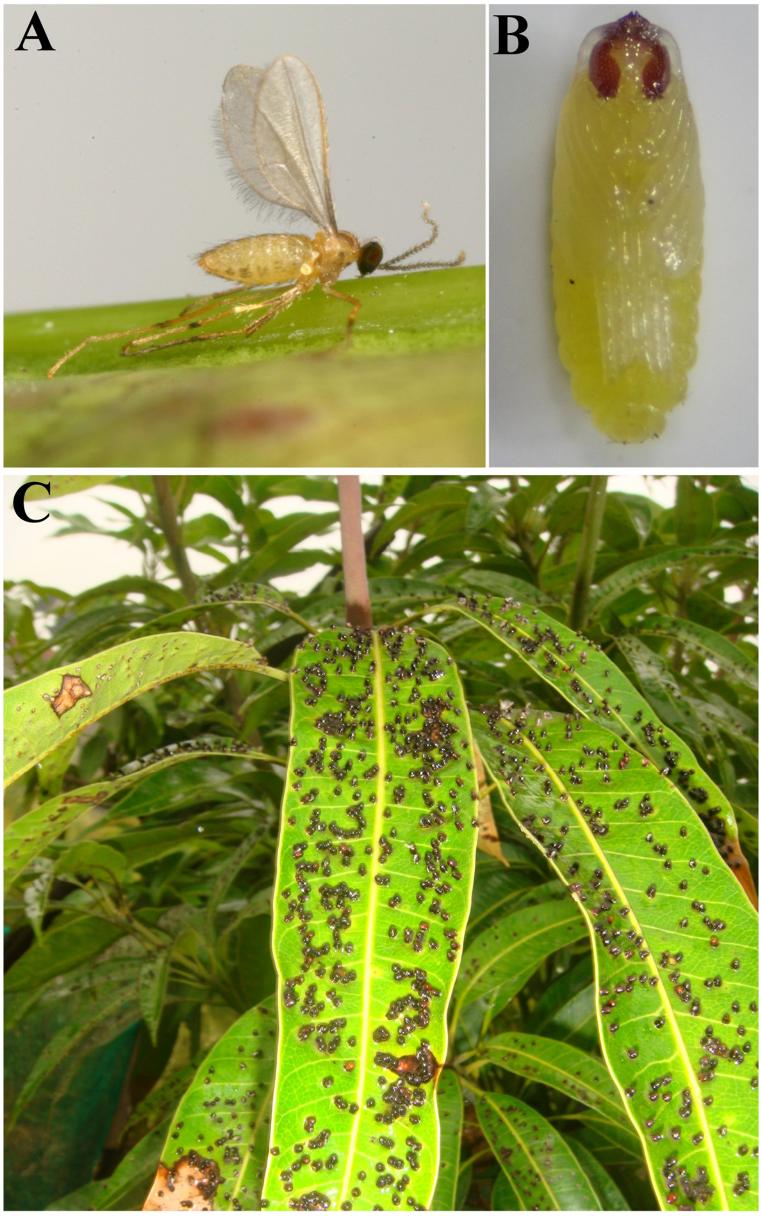
檬果壯鋏普癭蚋 (圖一 A) 在 2012 年 11 月之前，僅分布在高雄市若干行政區 (林園區、小港區、鳳山區) 與福建省金門縣。本種癭蚋與台灣普遍發生的檬果癭蚋 (*P. mangicola* (Shi, 1980))，均為檬果新梢期的葉部害蟲，屬於相同棲位 (niche) 的害蟲。但兩種癭蚋可藉由葉部的蟲癭形態、幼蟲化蛹行為與發生盛期予以區辨，例如檬果壯鋏普癭蚋在檬果葉片的蟲癭形態為錐狀型突起 (圖一 C)，檬果癭蚋為平坦狀的圓形蟲癭；檬果壯鋏普癭蚋之第 3 齡老熟若蟲，直接在蟲癭內部形成蛹期，檬果癭蚋第 3 齡老熟若蟲，化蛹之前，自葉片跳至土中化蛹。有關此兩種癭蚋的主要差異，詳如表三。

下列則為本研究於野外與室內所觀察的本種癭蚋之生態與行為習性。

交尾與產卵 成蟲羽化飛行之後，即具交尾的能力，成蟲白天潛藏於樹皮或土壤縫隙等陰涼的處所，至夜間開始活動，於葉片間飛舞。雌蟲偏好選擇甫展開的檬果新梢葉背部位產卵，雌蟲對檬果葉片 (質地) 選擇性較強，嫩葉經過 5～7 日之後，被產卵的機會相對降低，而適合被產卵的葉片，則可重覆被產卵；在非抽梢盛期，少數超過 2 週以上的幼葉，亦被選擇作為產卵的處所。

幼蟲生長發育與蟲癭形成 此種癭蚋幼蟲孵化後，直接侵入檬果葉肉組織取食為害，葉片受害部位圓點形、中心向上稍微突出、周圍為水浸狀的淡綠色暈斑，隨著幼蟲發育，受害部的葉肉組織細胞因受刺激而分裂增生，逐漸形成淡綠色錐狀突起的蟲癭，每個癭內部僅有 1 隻幼蟲蜷縮其內，以蟲癭內部增生的葉肉組織為食物。蟲癭大小則隨幼蟲齡期增長，形狀從初期的圓點形，逐漸成長為錐狀形，顏色則由初期的淡綠色，轉成黃褐色與咖啡色，成熟蟲癭則為黑色錐狀，此時的蟲癭已不再增生，其內部之葉肉細胞幾被第 3 齡老熟幼蟲食盡，僅留周圍堅硬、頂部較薄的黑色癭殼，並於蟲癭內部化蛹，蛹為裸蛹 (圖一 B)，頂部即為羽化破殼的部位。

本研究於野外逢機選擇受害檬果葉片，計算開展後新葉的蟲癭數，發現葉片長度在 15 cm 以下者，每片葉片的蟲癭數量約為 30～



圖一　檬果壯鋏普癭蚋之成蟲 (A) 與蛹 (B)；檬果葉片上由檬果壯鋏普癭蚋危害形成之錐狀蟲癭。
Fig. 1. Adult (A) and Pupa (B) of *Procontarinia robusta*; C: Mango leaves with blister-shaped galls produced by *Procontarinia robusta*.

166 個；葉片長度介於 15～20 cm 者，每片葉片的蟲癭數量約為 75～319 個；葉片長度在 20 cm 以上者，每片葉片的蟲癭數量約為 343～479 個。以上顯示蟲癭數量多少與新葉面積大小有關。

危害情形　本種癭蚋之蟲癭，其所需養份

表三　檬果癭蚋與檬果壯鋏普癭蚋之生物學、蟲癭形態與生態比較
Table 3. The comparisons on biology, gall morphology, and ecology between *Procontarinia mangicola* and *P. robusta*

	Procontarinia mangicola (Shi, 1980)	*Procontarinia robusta* Li, Bu & Zhang, 2003
Year recorded in Taiwan	2000	2011
Distribution	India, Thailand, China, Taiwan, Japan (Okinawa)	China (Fukien Prov.), Taiwan (Kaohsiung City, Kinmen Is.)
Probable invasive pathway	Both pests have the potential for being on the pathway to fresh mango leaves from its original distribution.	
Gall morphology	Blister-shaped gall.	Bell-shaped gall.
The number of larval chambers per gall	In general, each gall contains just one larval chamber. Sometimes, several larval chambers in one gall.	Each gall contains just one larval chamber.
Pupation habitats	After completing development, the larvae leave the galls and drop to the ground to pupate.	The mature larvae pupate inside the galls
Population dynamics	The highest peak of the larvae occurred from September to October.	The highest peak of the larvae occurred from September to March of the following year.

與水份皆來自樹體本身，因此會與樹體競爭養份與水份；再者，當檬果葉片密布蟲癭時，葉片可行光合作用的部位大幅減少，養份合成能力大為減弱，促使枝條弱化與展葉數不足，不利花梢形成或降低花梢所需養份來源，影響檬果產量；除此，本種癭蚋幼蟲孵化與發育過程，所造成之葉片傷口，將成為植物病原菌入侵的通道，促使葉部壞疽、焦枯與落葉。根據野外調查，新梢嫩葉蟲癭密度愈高者，在幼葉期畸形捲曲的比例愈高，受害葉片在蟲癭後期，即已壞疽、褐化與焦枯。

化蛹　第 3 齡幼蟲在發育後期，於蟲癭內以直立靜止、頭部朝上的位置，脫皮後進入蛹期。

對檬果品系的選擇性　本蟲已分布的產區，愛文、金煌與土樣等商業品系，均可受其危害。

(3) 內點刺蛾與小造橋夜蛾

野外調查結果顯示此兩種蛾類幼蟲，僅台中市霧峰區、彰化縣芬園鄉與南投縣草屯鎮的檬果園零星發生，主要發生時期則為每年 9 月至隔年 3 月之間。在室內飼育過程，發現內點刺蛾幼蟲以取食檬果成熟葉片為主，沿著葉脈咬食，因此葉部被取食之痕跡常為直線型的缺刻，老熟幼蟲直接於葉片背面或枝條間結繭；小造橋夜蛾則以檬果抽梢期嫩葉為主，以逢機取食方式，造成葉部不規則穿孔的取食痕跡，老熟幼蟲可直接於葉片表面吐絲，將葉片兩側邊緣予以綴結，並於其內化蛹。

討　　論

表一可知 1965～1988 年之間的檬果害蟲組成變化，從 64 種 (Tsai, 1965) 增至 80 種 (Lee, 1988)，其中介殼蟲增加 14 種，此與當時有介殼蟲分類專家協助鑑定有關。1988 年迄今，總計有 11 種昆蟲被誤判為檬果害蟲 (附錄一)，同時也有 11 種昆蟲被學者遺漏記

錄、或為臺灣檬果的新興害蟲或為新紀錄害蟲，故我國檬果害蟲仍為 80 種。

近 10 餘年來，可危害台灣檬果的外來種昆蟲，包括 2000 年入侵台灣的檬果癭蚋 (Anonymous, 2003; Chen and Chang, 2004) 與 2011 年入侵台灣與金門的檬果壯鋏普癭蚋，由此兩種的危害方式推論最可能的入侵途徑，應是隨著新梢引入臺灣，此也是為何需向農友持續宣導嚴禁私帶檬果組織進入我國的原因。再者，本研究調查過程，亦發現某些檬果蛾類害蟲之往昔生態資料似未明確，例如檬果蛀莖夜蛾的幼蟲，文獻記載之危害特性係從新梢莖頂或花梢鑽入蛀食 (Anonymous, 2003)，然本研究卻發現其幼蟲也可蛀食果實；檬果夜盜蛾雖為次要害蟲，卻為檬果幼葉期主要害蟲。

由上可知，臺灣重要作物之往昔蟲相與生態，與現今已有不同程度的差別，重新編修重要作物有害生物名錄與生態資料，實有必要。本研究係透過昆蟲分類學專業考證檬果害蟲物種變遷與田野實地調查之整合結果，期能提供學者建立重要作物害蟲名錄的參考模式。

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附錄一　臺灣檬果害蟲之存疑種清單

Appendix 1. The checklist for the dubious species of mango trees from Taiwan

Hemiptera

Cicadellidae

1. *Ledra auditura* Walker, 1858

Remarks: The ledrine leafhopper species *Ledra auditura* was recorded to feed on mango (Kato 1928), pear, apple, grapevine and *Quercus* sp. (Esaki & Ito 1954; Kato 1933; Shih *et al*. 2001). In fact, this species presents at low and middle altitudes (below 2500 m) in Taiwan. We have never found it in mango orchards during field surveys.

2. *Tartessus ferrugineus* Walker, 1851

Syn.: *Tartessus ferrugineus* var. *nigricosta*

Remarks: Schumacher (1915) noted that fig tree and orange are the host plants for this species. Furthermore, we also observed the nymphs and adults of this species feeding on the two plants of Euphorbiaceae, *Macaranga tanarius* (L.) Muell. -Arg. and *Mallotus japonicus* (Thunb.) Muell. -Arg., in the field of Taiwan (Shih *et al*. unpublished data). Although Kato (1928) described the species as one of mango insect pests at that time, but neither its adults nor nymphs of this species can survive on mango trees based on host or food plants tests under laboratory condition. Thus, we listed this species as occasional pest for mango trees of Taiwan.

Tropiduchidae

3. *Tambinia debilis* Stål, 1859

Syn.: *Ossa dimidiata* De Motschulsky, 1863

Remarks: Kato (1928) reported the tropiduchid species *Ossa dimiduata* De Motschulsky [a misspelling name of *O. dimidiate*] was one of mango insect pests in Taiwan, According to the monograph of Tropiduchidae of Melichar (1914), *O. dimidiata* is the synonym of *Tambinia debilis* Stål, 1859. Consequently, the species *T. debilis* was wrongly identified by Kato (1928) because it was never recorded in Taiwan based on the result of Yang *et al*. (1989).

Diaspididae

4. *Duplachionaspis graminis* (Green, 1896)

Remarks: This species was firstly listed as mango insect pest of Taiwan by Tsai (1965), and then Lee (1988) listed it again based on Tsai (1965). Tao (1978) reported 2 plants are the host plants for *D. divergens* (= *Chionaspis graminis* Green var. *divergens*) only. To date, no further informational reports of this species was collected from mango trees from Taiwan.

5. *Ischnaspis longirostris* (Signoret, 1882)

Syn.: *Ischnaspis filiformis* Douglas, 1887

Remarks: No information showed mango was the host plant for *I. longirostris* from Miwa (1943) and Tao (1978, 1999b) except Tsai (1965) and Lee (1988). But, this species was firstly recorded in Taiwan by Wong *et al*. (1999). Only 3 plant species (*Osmanthus fragrans* Lour., *Ixoro chinensis* Lam., and *Swietenia macropnylla* King.) were recorded as host plants for this species from Wong *et al*. (1999). Thus, Tsai's record was not correct.

Coleoptera

Scarabaeidae

6. *Adoretus sinicus* Burmeister, 1855

7. *Anomala albopilosa trachypyga* (Bates, 1866)

Syn.: *Euchlora trachypyga* Bates, 1866

8. *Anomala anthusa* Ohaus, 1938

9. *Anomala cypriogastra* Ohaus, 1938

10. *Anomala siniopyga* Ohaus, 1916

11. *Dasylepida nana* (Sharp, 1876)

Syn.: *Lepidiota nana* Sharp, 1876

Remarks: The scarabaeid beetles are not true insect pests of mango trees, because of the adults were passively attracted to the decayed fruits (e.g. caused by fungi, oriental fruit fly, physiological split of fruits, and so on) from anywhere. Moreover, the adults of some scarabaeid species belong to polyphagous and feed on the leaves of many plants. For example, Miwa (1943) noted 13 species of Scarabaeidae of Taiwan feed on the leaves or flowers of fruit trees, including *Anomala anthusa* Ohaus, *A. cupripes* (Hope), *A. cypriogastra* Ohaus, *A. expansa* (Bates), *A. sauteri* Ohaus, *A. siniopyga* Ohaus, *Lepidiota nana* Sharp [=*Dasylepida nana* (Sharp)], *Microtrichia formosana* Mooser, *Mimera testaceoviridis* Blanchard, *Popillia histeroides* Gyllenhal, *Popillia mutans* Newman, *Potosia* (*Calopotosia*) *aerata* Erichson, and *Potosia* (*Calopotosia*) *formosana* Moser. Among which, Tsai (1965) cited 7 species as mango pests of Taiwan, including *A. anthusa* Ohaus, *A. cupripes* (Hope), *A. cypriogastra* Ohaus, *A. expansa* (Bates), *A. siniopyga* Ohaus, *L. nana* Sharp, and *Protaetia orientalis sakaii* Kobayashi) [= *Potosia* (*Calopotosia*) *aerata* Niijima et Kinoshita]. Besides, Tsai (1965) added 2 scarabaeid species, *Anomala albopilosa trachypyga* (Bates) and *Adoretus sinicus* Burmeister, as mango pests of Taiwan.
No scientific papers showed that 9 scarabaeid species reported by Tsai (1965) attack mango trees in Taiwan before 1965. Afterwards, three scarabaeid species, *A. cupripes* (Hope), *A. expansa* (Bates), and *Protaetia orientalis sakaii* Kobayashi, were confirmed as mango pests from Anonymous (2003). Thus, this study excludes 6 scarabaeid species, *Adoretus sinicus* Burmeister, *Anomala albopilosa trachypyga* (Bates), *A. anthusa* Ohaus, *A. cypriogastra* Ohaus, *A. siniopyga* Ohaus, and *Dasylepida nana* (Sharp), from the checklist of mango pest insects of Taiwan.

A Revised and Annotated Checklist of Insects and Mites of Mangos from Taiwan

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ABSTRACT

An up-to-date annotated checklist of mango pests of Taiwan has been established based on historical literatures and field surveys in the past four years. The checklist of all 80 insects and six mites provided for each species a selective synonymy and a summary of some basic ecological details and economic importance. Among them, three species were recorded as emerging pests, namely *Amrasca biguttula* (Ishida), *Thosea sinensis* (Walker), and *Anomis flava* (Fabricius) whereas mango gall midge, *Procontarinia robusta* Li, Bu & Zhang, occurred in Taiwan for the first time. The comparisons on morphology, biology, and ecology between *Procontarinia mangicola* (Shi) and *P. robusta* Li, Bu & Zhang were briefly discussed. Furthermore, the following eleven species previous listed in historical literatures were excluded as dubious species: *Ledra auditura* Walker, *Tartessus ferrugineus* Walker, *Tambinia debilis* Stål, *Duplachionaspis graminis* (Green), *Ischnaspis longirostris* (Signoret), *Adoretus sinicus* Burmeister, *Anomala albopilosa trachypyga* (Bates), *Anomala anthusa* Ohaus, *Anomala cypriogastra* Ohaus, *Anomala siniopyga* Ohaus, and *Dasylepida nana* (Sharp).

Key words: checklist, insect, mite, mango, Taiwan

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